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NATURAL RESOURCES INVENTORY AND LAND EVALUATION IN SWITZERLAND

No 2 9 7 6 0

Principal Investigator:

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Zürich, June 24th, 1976

1. INTRODUCTION

The reporting period is characterized by a change and reorganisation of the data distribution as well as of our data processing system available at the various institutions engaged in image processing in Zurich.

Data reception and distribution switched from GSFC to the Telespazio S.A. and its ground station in Fucino near Rome, Italy (announced with letter by NASA of January 14th and by Telespazio of April 14th, 1976).

Numerous contacts took place but up to now no definite procedure for the data delivery could be arranged and no data was received. In addition to these organisational problems the creation of a new format for image data files (as described in Quarterly Report No 3) caused quite some technical problems. The adaption of all software to the new situation, which is still under progress, is wearisome and timeconsuming, but necessary for further progress.

Nevertheless significant scientific progress could be achieved and a new project started during this period in the field of

- snow mapping;
- spectral reflectance measurements of snow on the ground;
- attempt for automated comparison of multitemporal data for land use purposes by geometric correction of the data (new project).

2. ACCOMPLISHMENTS

2.1 Data processing

Adaptation of the existing software to the new data format, uniform for all research groups engaged in image processing in Zurich (Zurich data format), the testing of the various preprocessing and classification systems as well as the installation and setting in operation of the new PDP-11/40-RAMTEK-display system available now for interactive image analysis kept us busy for most of our time.

2.2 Snow mapping

A larger test area of about 2'700 km^2 in Grisons (Prätigau - Schanfigg - Landschaft Davos - Albula - Lenzerheide - Rheintal) was classified based on our software package (as described in Quarterly Report 1/2, 1975) for LANDSAT frame E-2090-09234 of April 22nd, 1975.

For the supervised digital classification with the PENN STATE ORSER SYSTEM (PPD-CLASS) 19 different categories (learning groups) combined into 5 main categories (Fig. 1) were set up. Particular interest was given to the melting zone (transition zone) with snow patches of various sizes intermixed with snowfree surfaces (vegetation, rocks, bare soil, roads etc.) to classify and map the position of the temporary snow line as exact as possible. The classification could be achieved by using MSS channels 5 and 7 only(because no bright snowfree features were present in the test area).

To locate the temporary snow line as best as possible careful ground controls and aerial underflights during the LANDSAT overflight were undertaken. The data then was correlated with the satellite data. For the classification output the Optronics Photomation System was used, which allows a geometric correction and a selection of an optimal scale within certain limitations (see Quarterly Report No 3, 1976). With this method it is possible to locate the transition zone between the compact snow cover and the totally snowfree areas with high accuracy for all different locations (relief, exposure, shadows etc.). The same test area was interpreted by analog methods on small-scale aerial photographs of the same date and the temporary snow line transferred onto a map 1:200'000 using a ZOOM Transfer Scope.

Fig. 2 shows the distribution of the 19 categories in the feature plane of LANDSAT-channels 5 and 7 by means of ellipsis, where the center presents the mean and the two main half-axis the standard deviation of each category.

Fig. 3 contains the classification output of the total test area for the 3 main categories "snow - transition zone - snowfree areas" in a scale approx. 1:240'000 and Fig. 4 an enlarged section of the region of Davos in a scale approx. 1:64'500. Both images were produced with the Optronics Photomation System. In Fig. 4 the transition zone in the valley bottoms as well as above the tree line is clearly indicated by its light gray tone.

Fig. 5 is an output with the line printer of a section of the same area as in Fig 4, using the same 3 main categories. The rather broad bänd of the transition zone representing the "snow line" is cleary recognizable.

Quantitative studies will be added on the areal extent of the snow cover and the transition zone and on the altitudinal position of the temporary snow line for the total area as well as in its regional differentiation and its correlation with other features (exposure, slope angle, surface elements etc.).

2.3 Spectral reflectance of snow measured with the EXOTECH-100

Measurements of various snow surfaces were taken at the ground and from a helicopter with the EXOTECH-100. At the same time the global radiance was measured, or the reflectance was calibrated by using a reference panel. From these data the target reflectance was calculated to allow a direct comparison of the results.

There is a clear correlation with the wavelength. For all snow types the target reflectance decreases with longer wavelengths between 0,5 - 1,1 μm and from MSS band 4 to 7 (Fig. 6).

A general correlation between the target reflectance and the condition of the snow surface or with the snow parameters measured on the ground (depth, water equivalent, temperature, roughness of the surface etc.) could not be established.

Therefore no definite conclusions can be made on the influence of these parameters on the target reflectance. On the other hand certain trends are obvious. A significant chance of the target reflectance occurs with the grain form(to be recognized best in channel 4), the snow depth (up to 30 cm), the wetness (to be recognized best with ratio 4/7 or 5/7), the pollution of the surface (channel 4) and partly with the roughness of the surface (channel 7).

All these parameters should be taken into account for further measurements. For reflectance measurements from a helicopter additional variables have to be considered such as atmospheric transmission, scattered light, relativ humidity etc.

A separation of the various snow types based on the target reflectance is possible to a certain extent. The fresh snow (sticky snow and slush snow) can be definitely separated from the old snow (spring snow, brittle snow, brittle crust and solid crust) except for old dry snow (Fig. 6). A better classification of snow types is only possible if additional snow parameters such as age, pollution, depth etc. are included, too. Fig. 6 shows the target reflectance for different snow types (mean value of measurements) in the 4 MSS-channels.

2.4 Geometric correction of LANDSAT data for multitemporal analysis

A new project was started to use multitemporal LANDSAT data in an automated classification procedure of land use features. The test area is the "Grosses Moos" near the Lake of Neuchâtel and the Lake of Bienne in Western part of Switzerland. To exactly correlate and compare pixels of the same area from different orbits geometrical transformations are needed. To identify exact ground points small reflecting mirrors were constructed and set up during LANDSAT overflights, to get a clear mark on the image of these ground points. Difficulties occur because the exact orbit parameters of the satellite passes are not known previous to the overflight. We have been asking Telespazio S.A. for assistance in this respect but no information was received until today whilst the experience had to be carried out in June. Approx. orbit parameters were derived from past satellite passes by calculating a mean orbit.

3. SIGNIFICANT RESULTS

Using MSS channels 5 and 7 and a supervised classification system with a PPD classification algorithm (Penn State Univ. ORSER System PPD-CLASS) it was possible to map the exact areal extent of the snow cover and of the transition zone with melting snow patches and snow free parts of various sizes over a large area under different aspects such as relief, exposure, shadows etc.
A correlation of the data from ground control, aerial underflights and earth resources satellites provided a very accurate and detailed qualitative as well as quantitative interpretation of the melting procedure of snow in high mountain environment, allowing a comparison of the extent and position of the transition zone in its regional variation and its correlation to exposure, slope angle, surface features etc.

Fig. 1 : Categories and main categories considered for an exact location of the transition zone (after H.P. STIRNEMANN)

no	category	main category
1	snow	I snow in sun
2	metamorphic snow 1	
3	metamorphic snow 2	
4	metamorphic snow 3	
5	metamorphic snow 4	
6	metamorphic snow 5	
7	metamorphic snow 6	
8	snow intermixed with rocks	
9	built-up areas with snow on roofs,roads etc. 1	
10	built-up areas with snow on roofs,roads etc. 2	
11	snow	II snow in shadow
12	snow intermixed with rocks	
13	transition zone - mixture of melting snow-patches and snowfree areas (vegetation, rocks, roads etc.)	III transition zone
14	needle-leaf forest	IV snowfree areas in sun
15	built-up areas	
16	open water 1	
17	open water 2	
18	grass	
19	needle-leaf forest	V snowfree areas in shadow

Fig. 2 : Presentation of the selected 19 categories (numbers as in Fig. 1) in form of ellipsis for LANDSAT-channels 5 and 7 (after H.P. STIRNEMANN)

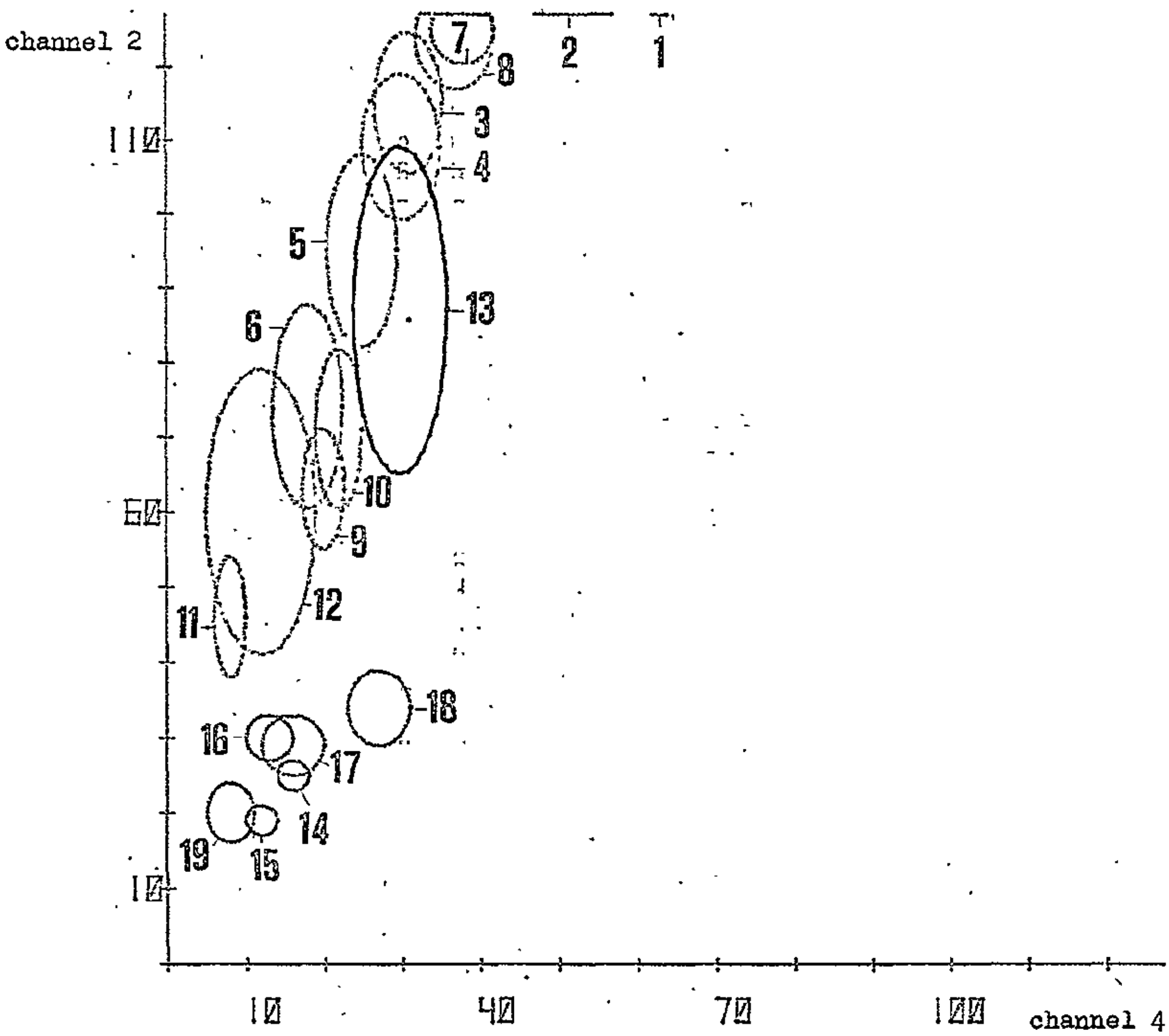
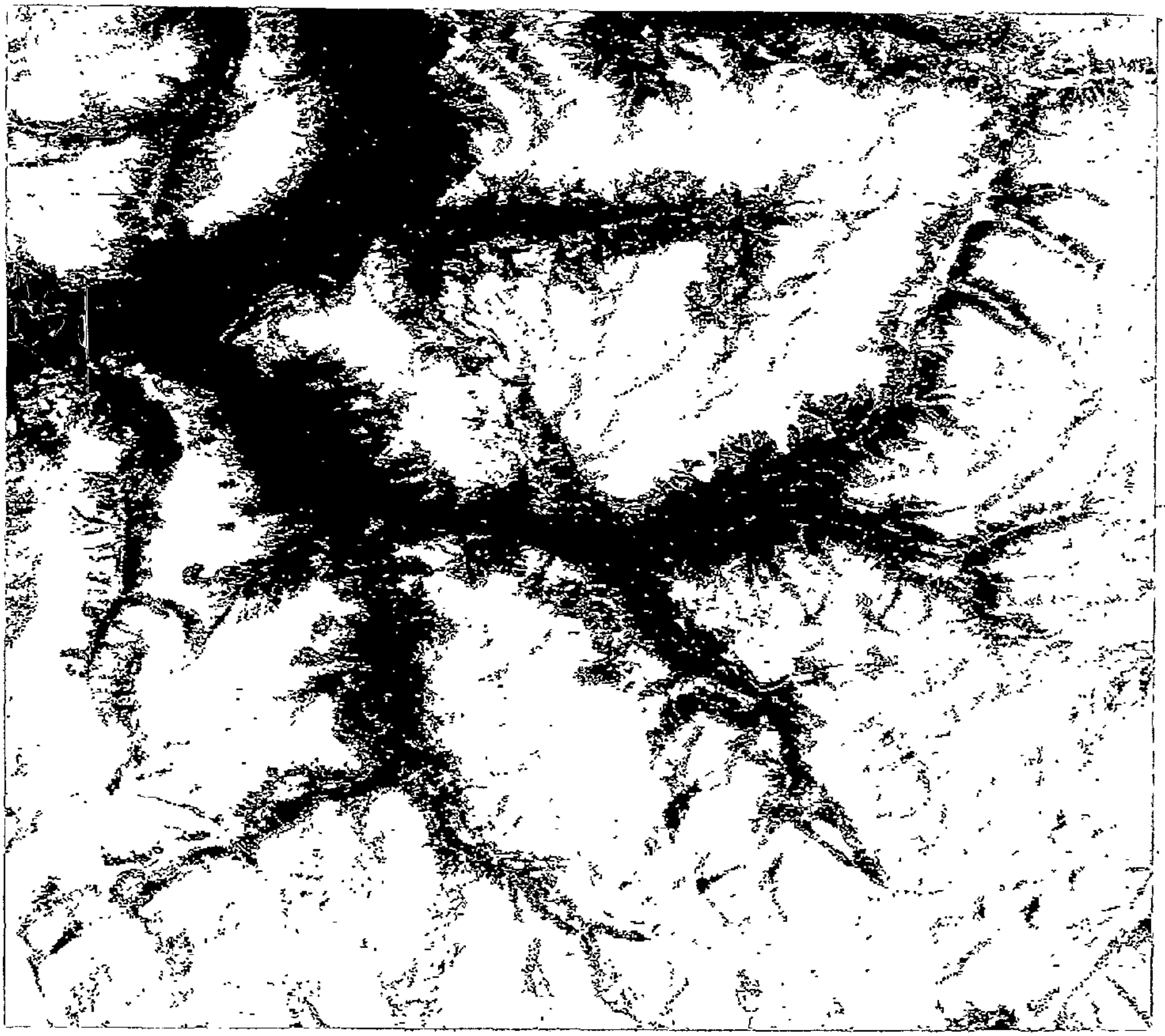


Fig. 3 : Digital mapping of snow and tranisiton zone for total test area Grisons; scale 1:240'000 (after H.P. STIRNEMANN)



white: snow
gray: transition zone
black: snowfree areas

Fig. 4 : Digital mapping of snow and transition zone for the region of Davos, Grisons; scale 1:64'500 (after H.P. STIRNEMANN)

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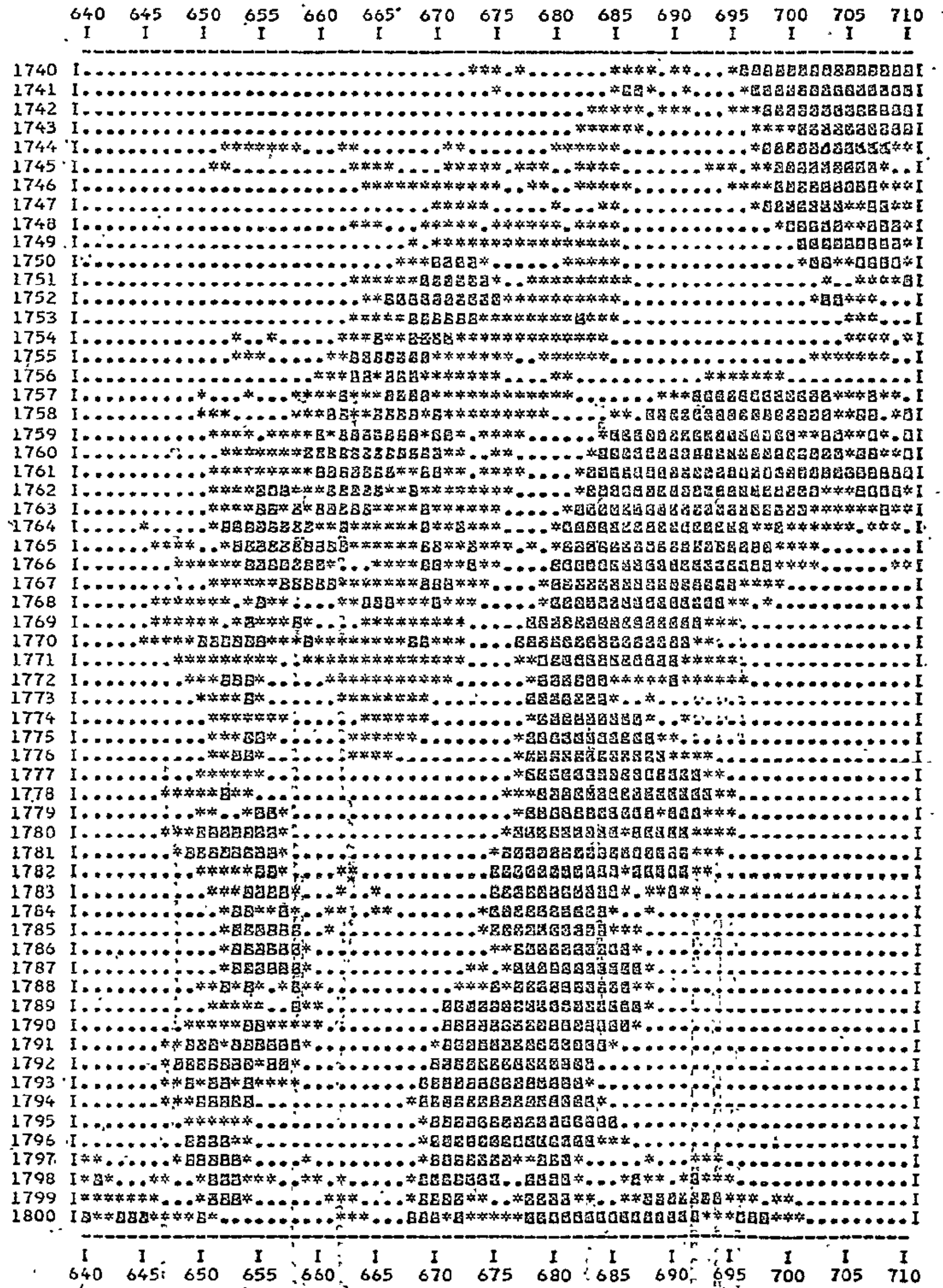
Fig. 5 : Output of PPD-classification of a section of Davos, Grisons (section included in Fig. 4) with MSS-channels 5 and 7 (after H.P. STIRNEMANN)



class 1	snowfree area	24.1 %
class 2	transition zone	22,3 %
class 3	snow	53,5 %

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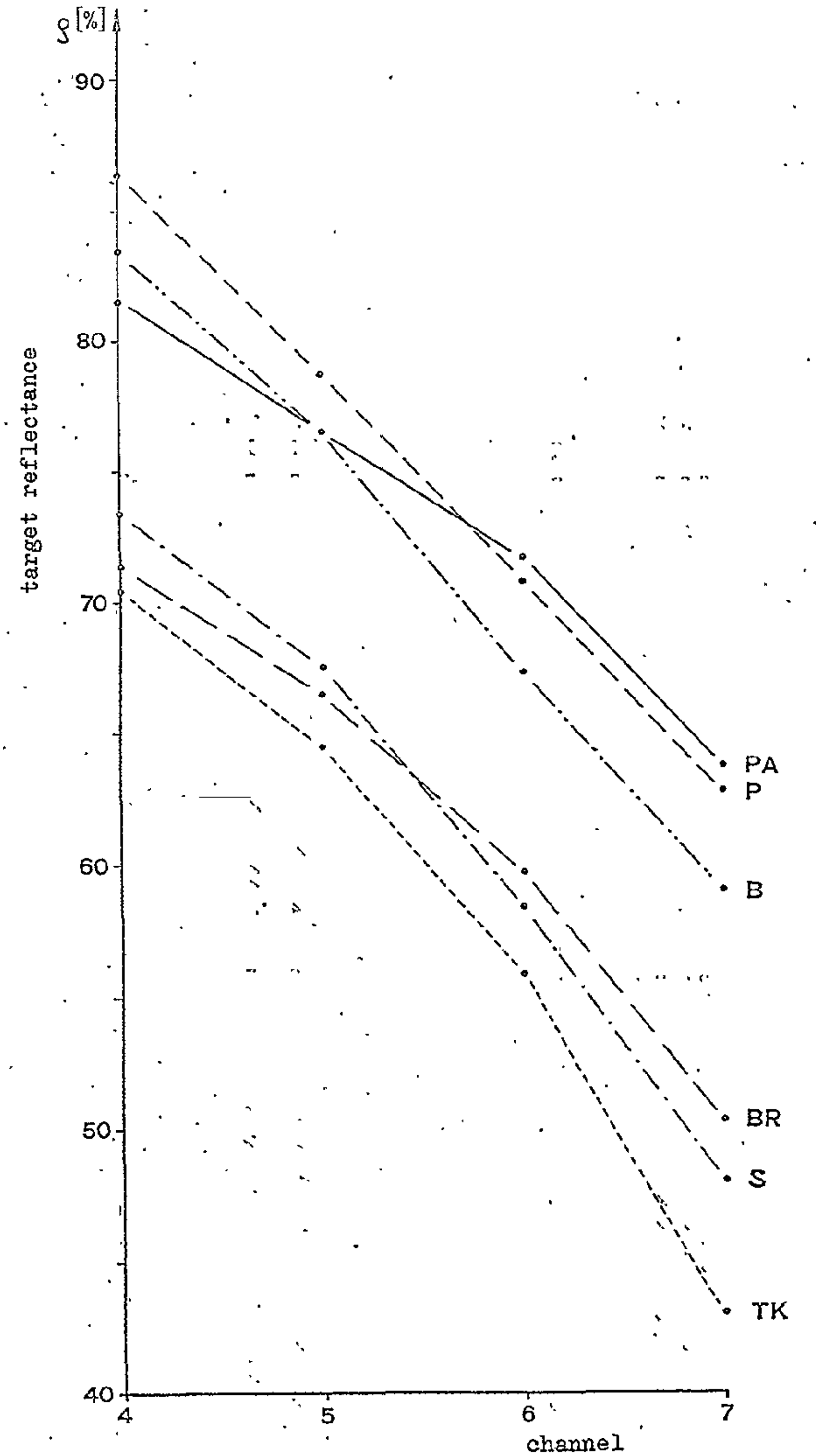
Fig. 6 : Reflectance of various snow types in the 4 LANDSAT-MSS-channels measured with EXOTECH-100 (after K. STAENZ)



Legend PA = powdery snow
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Principal Investigator: Prof.Dr.Harold HAEFNER
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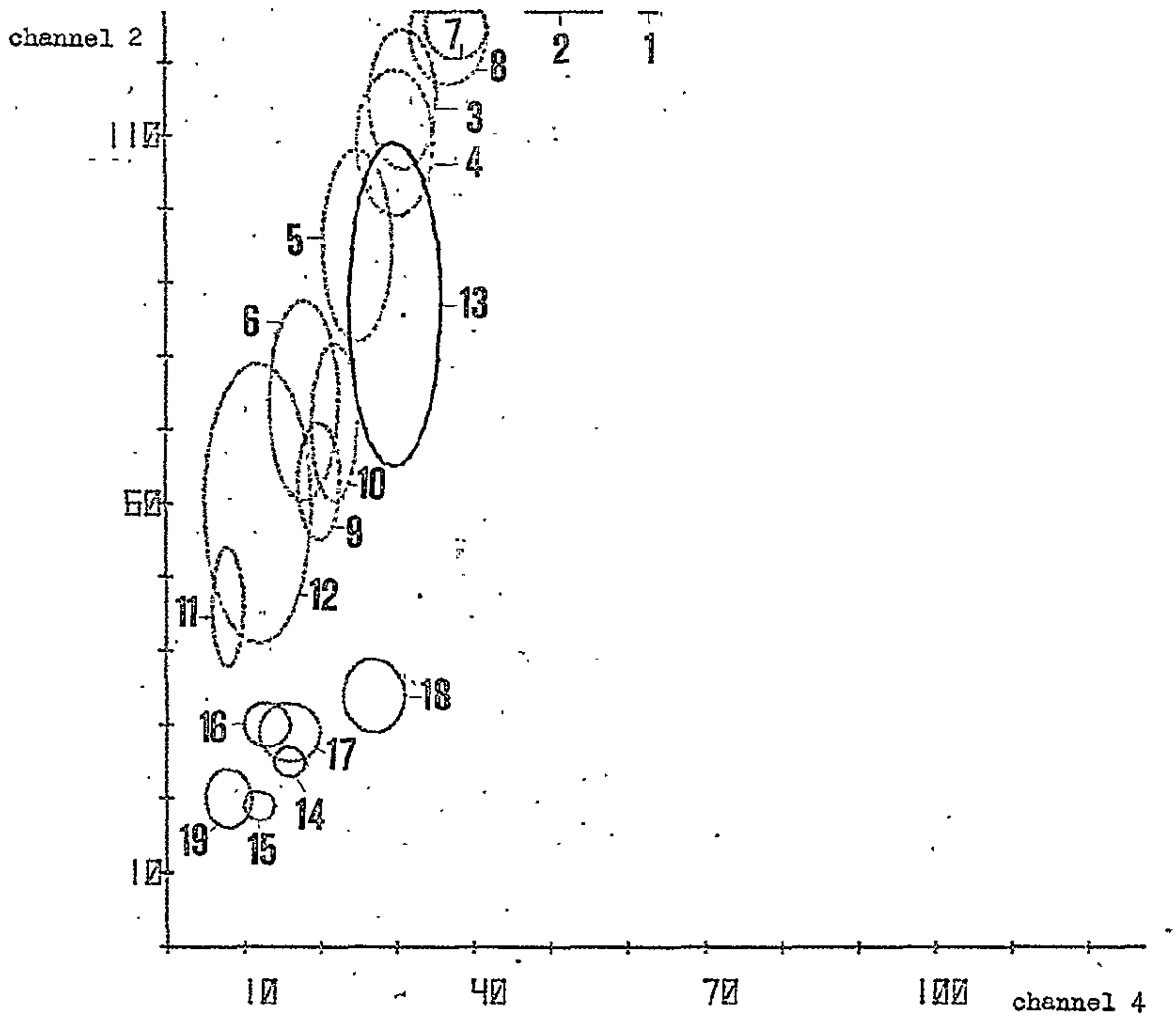

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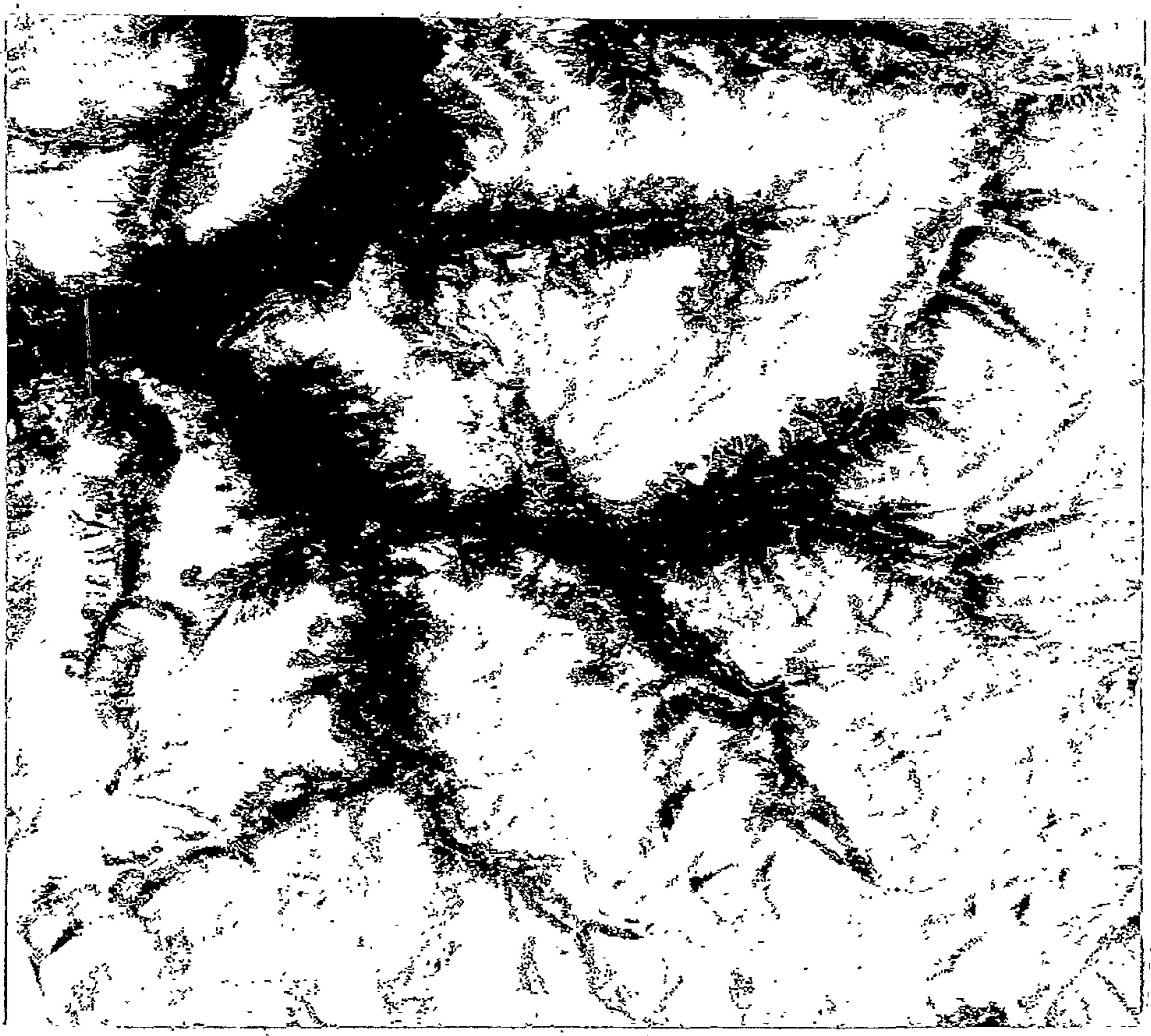

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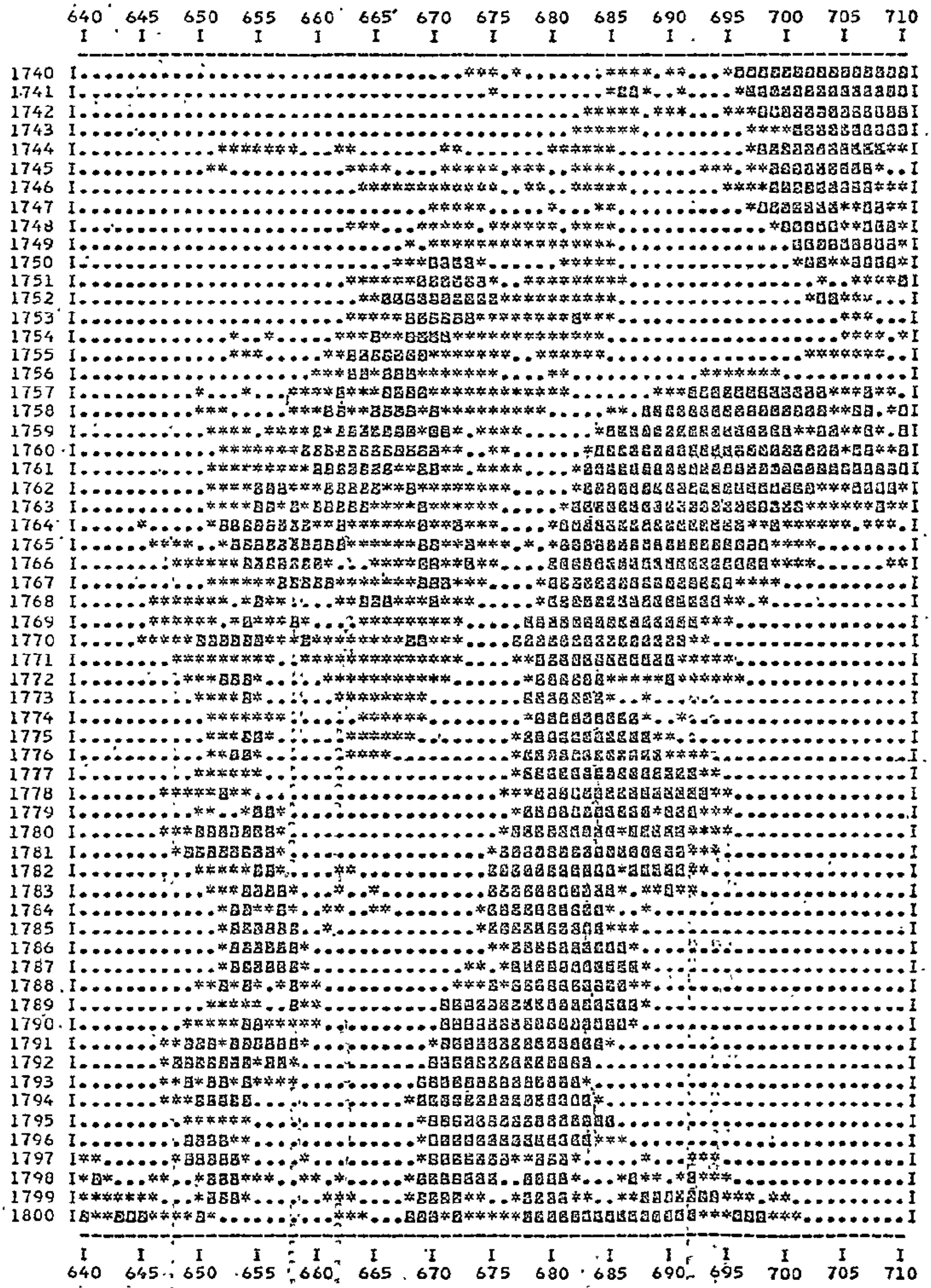

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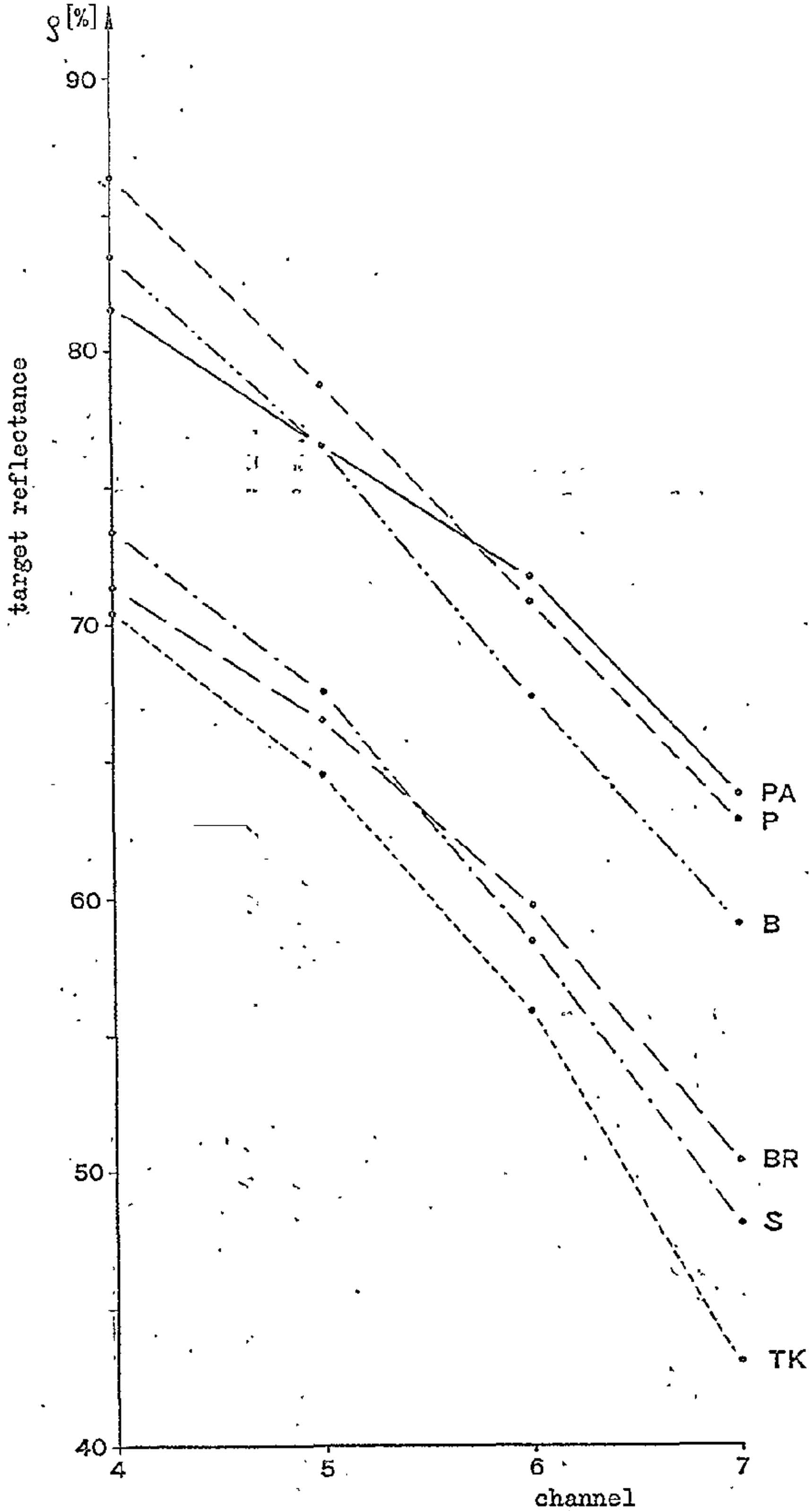

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